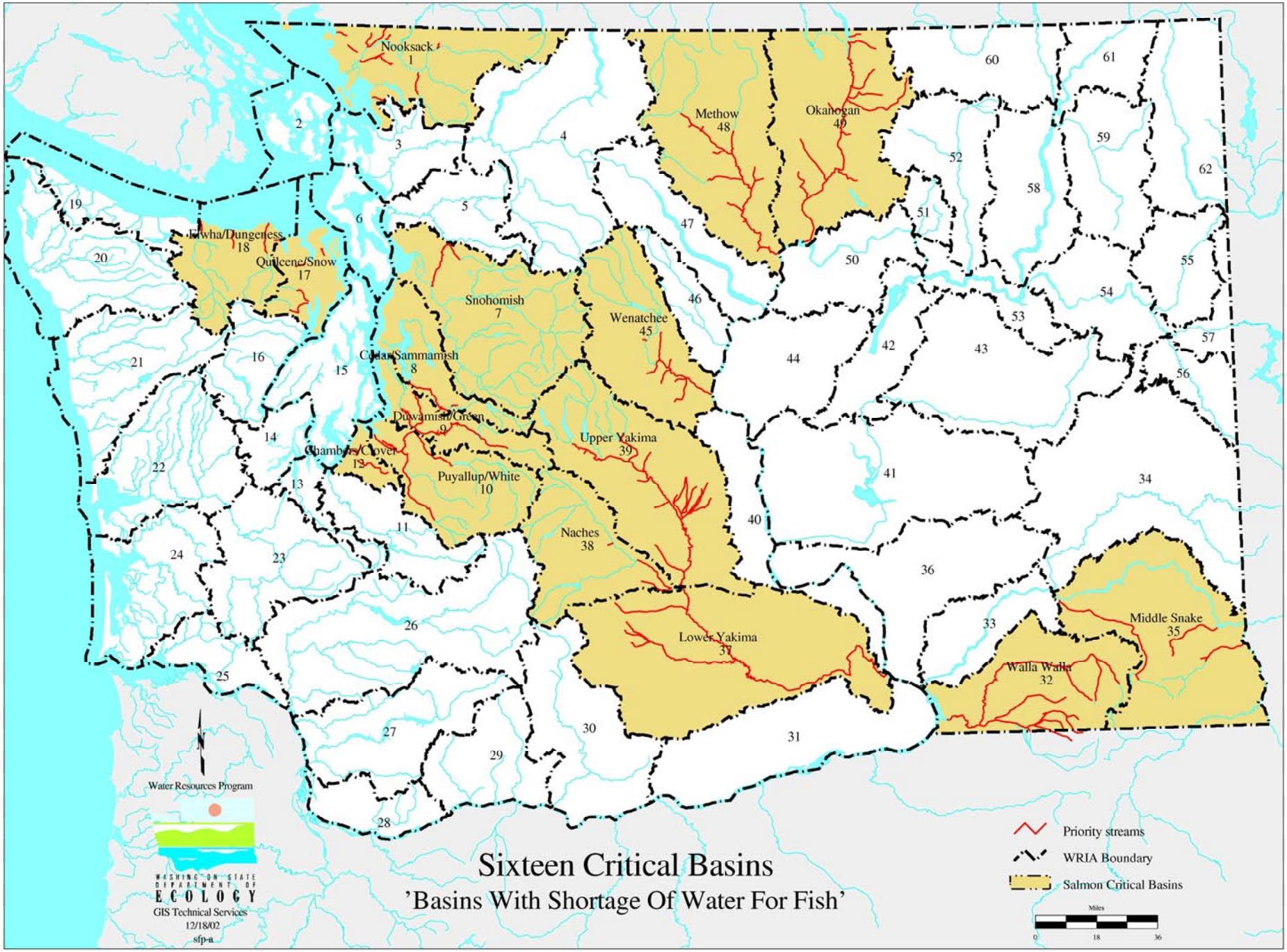

Sixteen Critical Basins

'Basins With Shortage Of Water For Fish'

3. Flow Restoration Prioritization for each Critical Basin

Nooksack River Watershed - WRIA 1

Inadequate streams flows have been identified as a limiting factor to salmonid productivity in several lowland tributaries of the main stem, South Fork, and North Fork of the Nooksack Watershed. Water is diverted primarily for agricultural purposes, but conversion of these lands for residential and commercial land use is accelerating. More than 30 streams and reaches have been closed to further water appropriations by rule. In addition, independent drainages such as Chuckanut, Dakota, and California Creeks have numerous surface water rights and have been closed to further appropriation. Most of these streams also suffer from water quality and temperature problems associated with poor riparian and floodplain conditions associated with agriculture and development.

Primary surface water users include power producers, commercial, industrial, and municipal/ domestic users, with agricultural use identified as being ranked relatively low overall. Groundwater is the primary source of water used for agriculture in this watershed. Groundwater withdrawal from shallow aquifers during the later summer months is thought to be a contributing factor to low flows. Stream channelization and the ditching of wetlands are thought to have significant impacts to aquifer storage and summer flows. However, surface water withdrawals are most significant in areas with intensive agriculture such as Dakota, California, and Chuckanut Creeks and some of the tributaries of lower Nooksack. It is here that water rights acquisition activities should be focused.

The South Fork Nooksack River is identified on the 303(d) list as having critical low surface flows and excessive temperatures during the summer months. Low flow limits pool habitat for rearing salmonids. There are numerous surface water rights in the lower South Fork which should be investigated for acquisition.

While groundwater withdrawals, hydrology alterations from land uses including impervious surfaces and logging,, and municipal and industrial withdrawals stream all contribute to low flows, flow restoration should be focused on acquisition of surface water rights in the smaller independent tributaries and tributaries of lower Nooksack. It is not expected that sufficient water could be acquired with the available budget to effect measurable change in mainstem flows.

Snohomish River Watershed – WRIA 7

Conditions of the streams and rivers of the Snohomish River watershed range from pristine to moderately impacted to heavily impacted (Pentec 1999). The range of conditions reflects the variety of land uses found in the watershed, including wilderness, commercial forestry, agriculture, residential development, and urbanization. Most of the water bodies greatly affected by human activities drain the suburban foothills or lie in the floodplains or the major rivers. Principal impacts to fish production have resulted from construction of dikes, channelization of floodplain tributaries, elimination of wetlands and estuarine habitat, riparian forest removal, non-point water quality pollution, industrial discharges, fish passage barriers, log rafting, and removal of large wood from channels.

The basin is recovering from some of the past impacts; many impacts of past land use actions remain present in the watershed. Rapid urbanization is the greatest new threat to salmonid habitat in the Snohomish watershed.

Water Quantity

While habitat loss through diking, ditching, wetland loss, loss of estuaries, and floodplain alteration have significantly reduced salmonid productivity, water quantity is also a recognized limiting factor. Low stream flow or associated elevated stream temperatures function as passage barriers and reduce rearing habitat during certain times of the year.

The Department of Ecology set instream flows and year round closures for the Snohomish River and it's tributaries in 1979. These established flows apply only to water right issued after the regulation was established. Instream flow regulations exist at 10 locations along streams within the watershed.

Instream flows on the Snohomish River near Monroe have typically not been met an average of 121 days during the year, especially between mid-July and mid-October. Minimum flows are not met during the month of October in half of all years, and are not met during most of the year (except during spring run off) in oneof ten years.

Up to 95 percent of the water allocated in the Snohomish River basin is from surface water. Municipal use account for 72 percent of the allocations, while 21 percent is used for domestic purposes, and the remainder for irrigation, fish culture and power generation. The 901 surface water rights issued by the Department of Ecology are equivalent to a flow of 743cfs. Allocations represent the volumes legally available for use if all wayter rights are exercised. As the water used approaches the amount allocated , due to continued development of water allocated by Seattle and Everett, further reductions of instream flow will occur. Diversions for municipal water supplies are highest during the summer months.

There is a relatively direct connection between shallow water aquifers and surface water in the Snohomish River watershed. These connections are most obvious during periods of low flows when the primary source of surface flow is shallow ground water. Thus, flows in this watershed are susceptible to increased impervious surface area associated with development, and increases

in the numbers of exempt wells.

Flow Restoration Opportunity

Changes in reservoir storage and management o the Sultan River have helped meet instream flows targets since 1985, however, the number of days that flow requirements have been met annually on the Snoqualmie River has been declining. Applications for appropriating new surface water rights for municipal use total 1000cfs, and applications for municipal groundwater water total 164 cfs.

Any additional appropriations must be reviewed critically to ensure that the established 1979 flows are maintained. Increased impervious surfaces and additional exempt wells alone will continue to have an impact on surface flows.

Because most of the water allocated in this basin is for municipal uses, and considering the current demand for more surface water, there may be little opportunity to acquire surface water in this basin. It is expected that there will be little water available, and that which is available will likely be prohibitively expensive. Acquisition efforts should focus on small tributaries which have water diversions associated with domestic of agricultural use. Stream flow can be reduced by over-allocation of groundwater and by creation of impervious surface, both lowering the water table by reducing groundwater recharge to streams

Marshland Drainages, Wood Creek 07.0036, Larimer Creek 07.0107, Thomas Creek 07.0108, Batt Slough, Hanson Slough

Increased peak flows, decreased summer low flow levels, and high sedimentation rates related to high levels of impervious surface in the headwaters of the Marshland tributaries, adversely impact the quality of salmonid habitat in the Marshland tributaries (Haas 2001); however, a study by Chris Konrad (USGS hydrologist) of perennial streams in the Puget Sound lowland concluded that while urbanization decreased winter baseflow, it did not significantly affect the quantity of summer base flow (study report interpretation by Dan Mathias, City of Everett). Increased impervious surface area associated with land use is the primary factor affecting flows in these sub-basins. Thus, acquisitions of surface waters are unlikely to resolve low flow problems other than perhaps a few localized streams or reaches. Care must be exercised to ensure that any acquisitions result in measurable flow increases.

Pilchuck River Mainstem

The City of Snohomish operates a domestic-supply water diversion dam at RM 26.4. The pool and weir fish ladder for the dam is located on the left-bank, which is the side of the river where sediment and debris tend to accumulate, necessitating regular and frequent maintenance of the fish ladder to ensure unrestricted fish passage (Tom Burns, WDFW). Impassable conditions over as little as a week during the adult return period could significantly impair salmonid production from the watershed upstream of the dam. Poaching of returning adult salmon and steelhead is also a routine concern at the fish ladder.

Surface water withdrawals from the Pilchuck River at RM 23 by the City of Snohomish can reduce summer and fall low flow in the river by 10-20% (Pentec 1999). No assessment of effects to resulting downstream salmonid production is available but salmonid passage at the diversion can be affected at low flows (Chamblin, WDFW).

Model estimates of impervious surface are 12% for the lower Pilchuck, 7% for the middle Pilchuck, and 1% for the upper Pilchuck (Purser and Simmonds 2001, as cited in SBSRTC 2002 DRAFT). Extensive floodplain alteration, diking, and increases in development suggest that a reduction in base flows should be occurring in the lower Pilchuck, although no reduction in base flows has been identified.

There may be limited opportunity to acquire water from the City of Snohomish, although drought year acquisitions to maintain fish passage may be cost effective. The effects of this diversion on salmonid production should be further investigated.

French Creek and tributaries

Low stream flows affect salmon productivity by reducing the amount of rearing habitat. HSPF modeling looked at the potential for low stream flows to affect summer instream habitat (Carroll 2000). The model predicted that at anticipated future development, Upper Spada, Upper Stables, Ghost Horse, Chain Lake, Upper Cripple, tributary to Cripple, Trench, and Lords Hill tributary creeks would likely go dry in summer. Portions of Cripple Creek, Alston, Stables, and all of Trench Creek currently dry up in summer months. The HSPF modeling identified a corresponding significant increase in peak flow magnitude in the watershed. French Creek peak flows have increased approximately 11-12% from forested conditions; the historic 100-year flood approximately equals the current 50-year flood (Washington State Conservation Commission / Northwest Indian Fisheries Commission , Limiting Factors Analysis, 2002 DRAFT). Further increase in peak flows is likely as further development occurs in the watershed. Stormwater detention and ability to infiltrate stormwater is limited by ~3% of the watershed soils being glacial till, that does not infiltrate well. Like many Puget Sound streams, the expansion of impervious surfaces and exempt well threaten instream flows. (Washington State Conservation Commission / Northwest Indian Fisheries Commission , Limiting Factors Analysis, 2002 DRAFT). Limited opportunity exists to restore increase stream flow because opportunities to acquire surface waters are limited, and additional data is needed to determine the feasibility of acquiring groundwater to preserve surface flow.

Snoqualmie River

Fish resource agencies have reached an agreement with Puget Sound Energy to maintain a minimum 300 cfs flow between the base of the falls and the outfall for power plant 2, approximately 0.5 mile downstream (1998 subbasin workshop). The flow has been set to allow fish access to the plunge pool below Snoqualmie Falls.

There are water withdrawals from the river occurring for agriculture although the quantities are unknown; affects on instream flow are also unknown (1998 subbasin workshop). Minimum flows established in 173-507 WAC vary from 700 cfs in late August to September to 2800 cfs

between November and the end of June (Washington State Conservation Commission / Northwest Indian Fisheries Commission , Limiting Factors Analysis, 2002 DRAFT). Opportunities to acquire water from agricultural users in the lower end of this basin should be further investigated.

Tolt/NF Tolt River , Moss Lake Creek, Stossel Creek, North Fork Creek, SF Tolt River, and tributaries

USGS gauge information before and after construction of the SF Tolt dam demonstrates altered peak flows, base flows, and flow timing since dam construction. (EBASCO Environmental 1993, as cited in SBSRTC 2002 DRAFT). The dam and associated reservoir on the SF Tolt were completed in 1963; the intent of the dam was for municipal water supply, and was not intended for flood control operations (Parametrix 2001). The SF Tolt flow is regulated by the SF Tolt water supply and hydroelectric projects. Water is withdrawn by the City of Seattle for municipal and industrial uses, under Superceding Reservoir Permit No. R-206 and Superseding Surface Water Permit No S1-10602. Instream flows are governed by a settlement agreement with resource agencies, associated with the federal license for FERC Project 2959 (FERC, 1988). Water storage in the SF reservoir has reduced lower Tolt River flood peaks by 29-36%, depending on the magnitude of the event (Parametrix 2001). Since reservoir flows are governed through FERC licensing and due to demand for municipal water, it is unlikely that water acquisitions would be feasible in this basin.

(Washington State Conservation Commission / Northwest Indian Fisheries Commission , Limiting Factors Analysis, 2002 DRAFT)

Other limiting factors

The analysis conducted by Haas and Collins (2001)(based primarily on Skagit data) suggests that the Snohomish River estuary is commonly a bottleneck to chinook production, with chinook experiencing density-dependent production constraints 45-87% of the time during the period 1968-1999. Several TAG participants question whether the model assumptions are accurate or valid enough to define the estuary as a “bottleneck”. Researchers have not been finding the degree of utilization of saltwater marshes by chinook that is represented in the model used by Haas and Collins (Houghton, Rowse). However, there is agreement on the importance of estuarine habitat, agreement that estuarine habitat has extensively altered, and that restoration of estuarine habitat is likely of highest priority in the lower watershed (Washington State Conservation Commission / Northwest Indian Fisheries Commission , Limiting Factors Analysis, 2002 DRAFT). The greatest reduction in coho salmon production capacity is estimated to have occurred through the disconnection and draining of large palustrine marshes within the floodplain (Haas and Collins 2001). It appears that more research may be necessary to determine the extent that estuary habitat is limiting in this basin prior to acquiring water to increase productivity for chinook and coho.

Cedar /Sammamish Watersheds - WRIA 8

There are numerous streams draining directly into Puget Sound within this WRIA, but little hydrological data is available. Further review of the cedar and Sammamish streams is needed to determine instream flow deficiencies or needs. As with other Puget Sound tributaries, many of the streams in this watershed have undergone significant hydrological changes due to land use modification (roads, extensive development and impervious surfaces, wetland loss, loss of forest cover etc.) One of the expected and observed effects of land use changes and proliferation of exempt wells has been lower base flows, especially in small tributaries.

The Lansburg Diversion Dam diverts up to 22 percent of the mean annual flow of the Cedar River for the City of Seattle. However, during drought conditions the percentage of flow diverted can be much higher. Flows from the upper river are managed under the City of Seattle's HCP. Low flows in the lower watershed are being analyzed by the WRIA 8 flow committee which is investigating alternative stream flow management options.

Rock Creek is seasonal above RM 2.6 and typically flows only from early December to early July. The Washington Conservation Commission's LFA indicates that this creek supports excellent habitat quality throughout its length, and increased flows would be expected to provide significant benefits. The City of Kent operates a well field near RM 1.7which may withdraw as much as 75 percent of the base flow from the creek. Instream flows can drop as low as 1.9 cfs when chinook and sockeye adults are migrating. These low flows can also significantly affect rearing juvenile steelhead, cutthroat, and coho. Due to the apparent direct continuity of the well field with surface flows, this may be one of the few instances where the acquisition of well water may be justified to increase instream flows during this initial stage of stream flow restoration.

The North Fork of Issaquah Creek is also significantly affected by groundwater withdrawals. However, without additional information regarding which of the ground water wells may be most contributing to low surface flow, ground water acquisition should not be a priority. The initial phase of stream flow restoration is focused on the acquisition of surface water rights unless continuity between ground and surface water is well established.

There are numerous limiting factors to salmonid recovery in the watershed and although stream flow is limiting, it appears relatively unfeasible to address during current flow restoration efforts and funding. In general, most withdrawals in the watershed are associated with groundwater or large municipal surface diversions. It is anticipated that there is little opportunity for cost effective water acquisition in this basin with the possible exception of Rock Creek because it is unlikely that municipalities will willingly sell their water rights due to the demand and cost of alternatives in this area.

Green River Watershed – WRIA 9

Low flows have been recognized as being limiting to salmonid production for many decades in the Green River Watershed. Perhaps no other basin has suffered such significant changes to its historic hydrology due to entire sub-basins being diverted into neighboring watersheds. Significant alterations to the hydrology of this watershed include:

- Diversion of the White River in 1906;
- Diversion of the Cedar/Black River in 1913;
- Construction of Tacoma Water Headworks Diversion Dam in 1911; and
- Construction of Howard Hanson (HHD) dam in 1962.

The City of Tacoma's diversion diverts up to 113cfs. The HHD was constructed to provide flood control and low flow enhancement in the lower river. Despite this, natural low flow conditions are not met 49 percent of the time, and during late summer instream flow requirements established by rule have only been met nine of the last 30 years. Low flows result in migration delays, a reduction in spatial rearing habitat, and alteration of adult spawning timing and location. This is leading to increased mortality through redd scour and adverse effect on early life stage development and fitness. Stream maintenance flood flows are also altered. Hydrology is further altered by development and other land use activities such as logging and forest road construction.

Big Soos Creek

Low instream flows have been identified as a limiting factor to salmonid productivity although the cause has not been specifically identified. The western portion of the watershed has suffered land use changes with an associated increase in impervious surface, which has significantly altered the hydrograph of this basin. The most significant diversion is at the WDFW hatchery although numerous, small residential diversions also exist on this stream.

Due to water demands in the Puget Sound Metropolitan area and potential cost associated with water acquisition, there is not likely to be many opportunities to acquire sufficient water to effect meaningful change in salmonid production in this basin. Opportunities to enhance flows in the Soos Creek Watershed should be explored further.

Puyallup River Watershed – WRIA 10

This was one of the first major watersheds in the state to undergo intensive industrial and urban development. Similar to many streams perched on glacial out-wash throughout the Puget Sound trough, many of the lowland small tributaries not fed by glaciers experience low flow conditions during late summers and early fall months, especially during periods of below normal precipitation.

Basin hydrology has been significantly altered primary by land use activity beginning with agriculture and logging, hydroelectric dams, and intensive urban, residential, and industrial development. For the 14 year time period between 1980 and 1993 the established minimum instream flow (MIF) of 1000cfs at the lower Puyallup River gage were not met an average of 35 days/year. Annual instream flows are continuing to decline despite establishment of MIF's in 1980; perhaps due to increased impervious surface area and exempt wells, associated with development. Unpermitted water withdrawals are also known to occur throughout the Puyallup River Basin. These unauthorized diversions typically occur during the low flow period, which compound their impacts to migrating and spawning salmonids.

Flows within the White River are diverted at a diversion dam located near Buckley at RM 23.4, through Lake Tapps and discharged back into the river at RM 3.5. Minimum flows within the bypass reach have ranged from 0 to 130cfs, and minimum bypass flows are yet to be established or agreed upon between Puget Sound Energy and resource agencies and Indian nations. Low flows within this bypass reach have resulted in significant impacts to migration, spawning, and rearing of salmonids. Increasing flows within this bypass reach may not be practical due to costs involved and may be better addressed through FERC licensing negotiations or some other venue such as the Lake Tapps Task Force (see below). Opportunities for cost-sharing a larger scale project to address flow problems should be investigated.

Wapato Creek is undergoing conversion from historical agricultural use to commercial, industrial, and residential use. There are surface water rights for up to 12 cfs that is used primarily form irrigation between May and September. There is virtually no remaining intact riparian vegetation and the channel and floodplain have been significantly altered. Salmonid use is currently limited to Simmons Creek which supports marginal habitat. This sub-basin is expected to continue to undergo significant alteration though increasingly intensive land use. There is some question whether flow restoration in this basin is cost-effective due to the expected future conditions associated with urbanization.

White River Hydroelectric Project / Lake Tapps Task Force - NMFS Biological Opinion: The Lake Tapps Task Force (LTTF) is developing their comments to the National Marine Fisheries Service (NMFS) regarding the NMFS Preliminary Draft Biological Opinion (PDBO) for the White River Hydroelectric Project. The LTTF would like WDFW to sign, or otherwise endorse their comments to NMFS. The first draft of some of the comments was distributed Friday, November 15, 2002. These comments currently are 54 pages long. LTTF will be finalizing their comments on Thursday, November 21, 2002. They want WDFW's endorsement at that time. The deadline for delivery of comments to NMFS is November 27, 2002.

While the LTTF has modified some of the language in their comments to satisfy concerns raised by Ecology, NMFS, and WDFW, they are not expected to change their comments regarding the water temperature criteria. The LTTF has identified that their temperature criteria recommendations are contrary to the technical opinion expressed by WDFW. So far, no literature has been provided to refute WDFW's or NMFS' literature citations for temperature criteria.

Ed Schild (Puget Sound Energy) is expected to contact Greg Hueckel this week to find out what policy direction will be taken by WDFW regarding temperature criteria, and regarding support of the LTTF's comment letter to NMFS. Staff continues to review and provide comments to the LTTF regarding the LTTF's response to the PDBO. Staff will be meeting with the LTTF work group again on Wednesday, November 20th, as well as attending the meeting on Thursday. In addition to the temperature criteria, it is likely the LTTF will be making recommendations that if adopted by NMFS will impact fish in the White and Puyallup Rivers.

Chambers-Clover Creek Watershed – WRIA 12

The Chambers-Clover Creek Watershed is located entirely in Pierce County, Washington between Puget Sound on the west and the community of Graham on the east. The watershed covers 144 square miles and includes approximately 2,020 acres of lakes, extensive wetlands, as well as Chambers Creek and Clover Creek (PCPWU, 1994). The Chambers-Clover Creek drainage originates from spring and ground-water discharge to springs and seeps in the northeast corner of the watershed. The ground-water discharge forms the headwaters of Clover Creek, which cuts through the center of the watershed, flowing from east to northwest, ending just west of Interstate 5. Clover Creek enters Steilacoom Lake at river mile (RM) 5.8. Chambers Creek is then formed from the outlet of Steilacoom Lake flowing 4.0 miles north and west down a narrow ravine where it is joined by Flett and Leach Creeks before it discharges to Puget Sound through Chambers Bay. The watershed is also typified by a number of small lakes. American Lake (the largest lake in the WRIA) is hydrologically linked to ground water and has no natural outlet.

Land Cover and Land Use

The Chambers-Clover Creek Watershed is located entirely in Pierce County. The WRIA is predominantly urbanized, with land use consisting of residential, urban, and light industrial activities. Forty-two percent of the land in the watershed is classified as built-up (PCPWU, 1994). Large portions (approximately 68%) of the Tacoma West and Clover Creek/Steilacoom Lake subbasins are considered urbanized. The Tacoma West Subbasin is distinguished by higher industrial and higher density commercial land uses, while the Clover Creek/Steilacoom Lake Subbasin is dominated by suburban and medium-density development (PCPWU, 1994). The least urbanized portion of the Chambers-Clover Creek Watershed is the American Lake Subbasin, particularly within the northern portion of Fort Lewis and along the southwest portion of the subbasin (PCPWU, 1994).

The American Lake Subbasin includes Sequalitchew Lake and Sequalitchew Creek which flows west into Puget Sound. The development of the Town of DuPont and surface-water usage at the Fort Lewis Army Reservation has severely impaired the flow and character of Sequalitchew Creek, which has been documented in a report by Andrews and Swint (1994). The 38.4-square mile drainage basin of Sequalitchew Creek includes Kinsey Marsh which drains into American Lake through Murray Creek; seasonal overflow from American Lake flows into Sequalitchew Lake from which Sequalitchew Creek begins. A Fort Lewis diversion dam, canal, and a set of complicated culverts carry water from the creek into Puget Sound at Tatsolo Point. The remainder of the natural creek flows through Edmond Marsh, a 130-acre wetland bordering Fort Lewis and DuPont, then through a lush, steep canyon, supplemented by a spring and several seeps, into a salt marsh, and finally through a culvert under a railroad dike into the Sound.

Agricultural land includes active and open agriculture. Less than 300 acres (0.3 % of the watershed) are classified as agricultural. Natural cover accounts for 36 percent of the watershed and includes primarily grasses, shrubs, and brush, but schools, golf courses, cemeteries, landfills, and small farms also were included in this classification scheme (PCPWU, 1994). The Clover Creek Subbasin supports approximately 19,000 acres of natural habitat or 43 percent of the subbasin. The American Lake Subbasin is 38 percent natural cover, or approximately 6,500

acres, much of which lies within Fort Lewis (PCPWU, 1994). The population of Pierce County increased by 112.5 percent from 1950 to 1990. Between 1980 and 1990, the population of the county increased 20.7 percent The majority of the population growth during the 1980s occurred in the unincorporated areas of the county.

The interconnection between ground and surface water is evidenced by the relatively high proportion of recharge contributed from stormwater infiltration to ground water (21 percent). Precipitation accounts for 66 percent of the recharge, and septic tank drainage and surface water bodies account for 11 and 2 percent, respectively (Brown and Caldwell, 1985). Thus, increasing urbanization can be expected to continue to adversely affect instream flows within this WRIA.

Water Rights and Claims

Water-use statistics for the Chambers-Clover Creek Watershed have not been consistently recorded over the years. WDFW biologists have observed illegal water diversions for irrigation or other purposes (Jim Fraser, Personal Comm.); however, it is also likely that numerous recorded or claimed rights are no longer in use. Until actual use is known, it must be assumed that all recorded water rights and claims are fully in use today and represent consumptive water use.

Surface-water use has increased steadily, with a total annual withdrawal of 131 cubic feet per second (cfs) and 2,478 per year acre-feet authorized from the surface waters of the watershed. As of September 1994, one application, requesting a total of 12 cfs for fish propagation was on file at Ecology . Ground-water withdrawals have shown a steady increase, and a total annual withdrawal of 453.2 cfs (203,401 gallons per minute [gpm]) and 144,705 acre-feet per year has been authorized from the watershed. As of September 1994, 17 applications for additional withdrawal, requesting a total of 50 cfs (22,395 gpm) for municipal supply, domestic supply, and irrigation were on file. After the 1980 closure of Chambers, Clover, and Sequalitchew Creeks and their tributaries from surface water withdrawal, the rise in water consumption has been dominated by the granting of ground-water rights.

A surface-water right issued in 1990 for 96 cfs is a non-consumptive use (for flood control) that diverts flow from Leach Creek into culverts in Nalley Valley. This diversion occurs to prevent flooding and is only triggered when Leach Creek flows exceed 60 cfs.

In addition, the Puyallup Tribe has fishing rights within the watershed that are considered to predate water rights and claims. In accordance with the Bolt Phase II decision, water quantity and water quality must be maintained to ensure adequate salmonid habitat. Implementation of this decision may require Ecology to consider the tribal fishing rights as the driving factor in water allocations, as well as issuance of wastewater-discharge permits and non-point-source pollutant controls.

As previously indicated, the original purpose of the Fort Lewis diversion is unclear, and detailed analysis of its effect on flow is difficult because of the lack of data on stream flows before construction of the diversion dam and canal. Controversy remains regarding authorization of the diversion, its effect on the
salmon fishery, and current authority and responsibility for the dam's operation.

Fish Use

Anadromous salmonids found within the Chambers-Clover Creek watershed include hatchery and wild summer chinook (*Oncorhynchus tshawytscha*), hatchery and wild coho (*O. kisutch*), winter chum (*O. keta*), steelhead (*O. mykiss*), and cutthroat trout (*O. clarki*) (PCPWU, 1994). Chambers Creek formerly had a native summer run of chum salmon. Their escapement and number of fish returning to the creek to spawn ranged from 0 to 200 individuals between 1975 and 1980. They spawned from mid through late October in Chambers and Leach Creeks. The last three fish were seen in October of 1983. The stock has been declared extinct (WDFW, 1993; PCPWU, 1994).

Adult or juvenile salmon and/or steelhead trout are present within the basin throughout the entire year. Physical passage barriers, both anthropogenic and natural, pose a serious problem to anadromous fish movement and habitat conditions are generally very poor. A dam with a spillway and fish ladder forms the head of Chambers Bay approximately 0.75 miles upstream from the Burlington Northern Railroad dike at tidewater. In addition, a fish trap near the mouth of Chambers Creek and an impassible dam at the outlet of Steilacoom Lake, restrict the passage of anadromous fish. All salmonids that enter Chambers Creek are netted and placed on the upstream side of the fish trap. Because of existing passage barriers, the overall habitat available for anadromous salmonid production is limited to 9.0 stream miles in the lower watershed. However, salmonid spawning habitat in the lower watershed is rated as fair to excellent quality.

Anadromous fish production in the Chambers-Clover Creek Watershed is depressed as has been so for many decades.

Streamflow Status

Some of the conditions adversely affecting anadromous salmon and steelhead include seasonal flooding (altered hydrograph due to increased impervious surface area), low summer flows, unstable stream beds, physical barriers, poor water quality, high stream temperatures, the destruction of spawning habitat, and over harvest of wild stocks. Low streamflows experienced over a period of several years are known to be particularly problematic in this watershed.

No minimum instream-flow requirements have been established for this watershed. However, WAC 173-512 (1980) closed Chambers, Clover, and Sequalitchew Creeks, and their tributaries (including lakes) to further water withdrawals.

Because the summer flows have not been measured since 1986 at three of the gages, no conclusions can be drawn about trends in low flows. For the Fircrest Gage on Leach Creek, the recent record indicates below average seven-day low flows. Increasing demands for surface and ground water can be expected to continue to affect low flows in this basin as development continues. Furthermore, increases in impervious surface areas due to expanding urbanization reduces ground-water recharge and, thereby would reduce base flows in the drainage basin. The effects of increased water demands through exempt wells and reduced ground-water recharge will have even greater consequences to flows, especially during extended drought conditions.

Summary and Conclusions

The National Groundwater Association classified the uppermost aquifer as either moderately or highly vulnerable to contamination because of the excessively well drained soils that are common throughout the area (EPA, 1993). The vulnerability has been substantiated by a number of instances of contamination. The interconnection between surface water and ground water is apparent in this watershed. Increased demand for ground water probably have affected low flows in the streams, although insufficient data is currently available to draw quantitative conclusions. Increases in impervious surface areas from expanding urbanization have reduced ground-water recharge and base flow.

To assist in re-establishing flows, a program to account for all water withdrawals (including the exempt withdrawals of less than 5,000 gallons per day) should be established. Unauthorized withdrawals also should be eliminated.

The measurement of actual water use or quantification of water rights has not been assessed by Department of Ecology for a number of reasons (Ecology, 1995). First, unauthorized-water users and claimed rights no longer exercised prevent correlation between the amount of water being used and the amount which are of water allocated by rights. No procedure is in place to track whether or not water rights issued in the past are still used. Second, most water-right claimants did not specify quantities on their claims; therefore, quantities for claims were estimated. A survey of actual use is critical to proper management of the resource. Third, unauthorized withdrawal has been documented but not eliminated. Such water use should be investigated and enforcement action taken, where appropriate.

Federal government facilities do not need water rights and are not required to report water use or consumption to the State of Washington. McChord Air Force Base and Fort Lewis operate their own water supplies independent of Washington's system of water management. This complicates the ability to assess water use and restoration opportunity in the basin.

Thus, it would not be prudent to acquire surface water for salmonid recovery in this basin until an inventory and measurement of actual water use is completed. Assurances are also needed to avoids instream flows from being affected by continued increases in exempt well use and increased impervious surface areas. It is unlikely that large industrial water users would be willing to sell water in this basin, especially when few alternative sources are available. Management of land use to maintain the status quo may be more feasible than water acquisition.

Quilcene River Watershed - WRIA 17

Surface diversions are primarily limited to the Big (17.9cfs) and Little Quilcene (4.1cfs) sub-basins due to the City of Port Townsend's diversions, which total 87 percent of all diversions. The next largest diversions within this WRIA occur in West Sequim Bay and the Ludlow Sub-basins. The sum of all consumptive surface water diversions is 63.6cfs. Irrigation is the second largest use of diverted surface water. An additional 287 water claims exist within this WRIA, totaling 45.5cfs.

Chimicum Creek has water rights totaling 2.9cfs, and claims totaling 6.6cfs, while the MMF for this creek averages only 5.05cfs between June and September. Thus, the stream may be dewatered during periods of low flow.

Salmon and Snow Creeks have surface water diversions totaling 1.6cfs and claims totaling 2.02, which is primarily for irrigation.

None of the streams identified meet or exceed instream flow recommendations developed by Department of Ecology and Washington Department of Fish and Wildlife. Thus, water rights should be reviewed for acquisitions in this basin. Because the City of Port Townsend's large diversion results in 87 percent of all diversions, acquisitions should be focused on low water year or seasonal leases or acquisitions, conservation efforts, and seeking alternative water supplies. It is apparently unlikely that the city would interested in selling existing water. Providing storage of water during the high flow period to provide city water during the low flow period may be another option worth exploring.

Groundwater withdrawals and land use are increasing concerns within this WRIA. Increased withdrawals in impervious surfaces are expected to be significant in their effects on surface flows.

Dungeness/ Elwha Watershed - WRIA 18

This watershed is somewhat unique in that it is a west side stream with numerous gravity diversions for irrigated agriculture, similar to many streams of eastern Washington. This watershed is also unique in that it supports one of the most diverse assemblages of salmonid stocks in the state. IFIM models indicate that even relatively small increases in instream flow could result in significant benefit to salmonids, particularly rearing habitat for chinook. In addition to the agreement between resource agencies and irrigation districts regarding instream flows and diversions, there are other opportunities to increase flow through additional acquisition of water.

Due to the significant continuity between the groundwater and surface water in this basin, it is suspected that the 3500+ ground water rights may be resulting in significant surface water impacts. Existing water rights significantly exceed available surface flows in the mainstem during the summer and fall months. Low flow adversely affects rearing and spawning habitat, as well as adult salmonid migration during late summer and fall. Due to the high porosity of the substrata there may be opportunity to conserve water through conservation efforts to reduce conveyance losses of the open ditch delivery systems.

Morse Creek is a moderate sized creek located between the Dungeness and Elwha Rivers and is known to have one produced a surprising diversity of salmonids stocks for a stream of it's size. There is a City diversion at RM 7.0 which could result in limiting flows during late summer months if the right is fully appropriated. Up to 19CFS could be diverted by the City of Port Angeles. Total surface rights are 24cfs with numerous additional claims. Sufficient water should be sought to secure sufficient future instream flow needs for fish.

The Elwha River is one of the largest and perhaps historically the most productive salmonid stream of the Olympic Peninsula. This river historically produced a great diversity of salmonid stocks including perhaps some of the largest chinook in the state. The average minimum flow in the Elwha is 350cfs, while surface withdrawals may total 215cfs. Although full appropriation of water is rarely exercised, up to 50 percent of the stream flow has been diverted. Flows below 300cfs can result in significant impacts to rearing salmonids, and low summer flows can result in elevated stream temperatures and increased incidence of disease in chinook. The primary water user is the City of Port Angeles, which has rights to 150cfs.

Bell Creek is a small tributary located near the mouth of Sequim Bay. A diversion just upstream of Carrie Lake Park diverts up to 50 percent of the stream flow. As with other small tributaries in the Dungeness plain, flows are further compromised by conservation efforts on gravity diversions from the Dungeness River, due to interconnected sub-surface hyphoreic flow with the Dungeness.

Walla Walla Watershed - WRIA 32

Stream flows are limiting to salmonid production in most of the tributaries of the Walla Walla Basin including the mainstem due primarily to irrigation diversions. Summer steelhead access and rearing habitat is primarily limited by low flows, although "push-up" diversion dams exist throughout the watershed, which result in passage barriers during spring migration.

While the stream flow prioritization matrix weights small streams more favorably for restoration due to reduced instream flow needs to achieve target flows, it is recognized that fish access must be provided through mainstem reaches downstream for successful salmon recovery.

While acquisition of senior water rights in the lower reaches of the Walla Walla River would be of highest priority, seasonal acquisition of junior water right during fall and spring months to extend passage times for adult steelhead would also be valuable. Alternatively, senior water rights acquired low in the basin would require junior holders to release flows downstream during drought or late summer conditions, though not from specific upstream reaches.

One of the primary reasons for the relatively low rankings of many of the streams in the Walla Walla River Basin is the poor condition of existing habitat. However, habitat conditions are relatively good in the headwaters of the Mill Creek and Touchet River watersheds including their tributaries (Coppei Creek, North and South Forks Touchet, and Blue Creek), which are located within relatively remote forested zones. Thus, providing access to this relatively intact habitat should be a high priority.

Tributaries in the lower Walla Walla basin also have potential for salmonid and stream flow restoration but will also require habitat restoration efforts as well. Yellowhawk Creek, which is actually a braid of Mill Creek, is relatively unique in that it functions as the primary channel for summer flow below Bennington Dam during the summer months when water is diverted from Mill Creek. Due to the poor passage and habitat conditions in Mill Creek below Bennington Dam, one alternative suggests that Yellowhawk Creek should permanently serve as the primary channel for fish passage and fish should be screened out of lower Mill Creek. If so, flow, passage, and habitat restoration should be focused on Yellowhawk Creek, while lower Mill Creek would be used as a high flow or flood control channel.

Dry Creek, Cottonwood Creek, and perhaps the Little Walla Walla River, Pine Creek, and Mud Creek currently support remnant populations of summer steelhead and have recovery potential. However, portions of Pine Creek, Little Walla Walla River, and Cottonwood Creek extend into Oregon and the success of flow restoration efforts is somewhat dependent on collaboration with the State of Oregon. In addition, habitat conditions of tributaries located in areas of intensive agricultural use generally have poor habitat conditions. Expected future habitat conditions in these tributaries of the lower Walla Walla Basin should be a determining factor in the final prioritization process. The Little Walla Walla River and its associated braids are actually distributaries of the Walla Walla River and a fish screen prevents juvenile access from the upstream end. However, both adults and juveniles do migrate into this system from the lower end. Multiple springs arise from groundwater in Washington thought to be due to groundwater surcharge from irrigation in Oregon. There is some question regarding connectivity between

these springs and conservation efforts occurring in this tributary. Water right acquisitions in this area should be carefully evaluated to ensure that instream flows will be preserved if acquired.

Middle Snake River Watershed - WRIA 35

The Tucannon, and Asotin drainages are the primary streams within the WRIA in which low flows are identified as being limiting to salmonid production.

Asotin Creek - A total of five cfs of surface water diversions are allocated for Asotin Creek. WDFW has recommended that a minimum of 15 cfs be maintained within the creek to meet instream flow needs for fish at SR128 between July 1 and March 31, and 70cfs April 1 through June 30th. There are two surface diversions in the lower two miles of Charley Creek contributing to loss of habitat and create a barrier to migration during low flow periods.

Alpowa Creek is the only perennial stream within this sub-basin. Lows flows average about five cfs during the low flow period (July to October) while diversions total approximately 7 cfs. Steelhead production could benefit significantly by providing additional flow. However, there is significant impact on the riparian and floodplain habitat associated with ranching which must also be addressed for salmonid recovery to occur.

Tucannon River - A total of 67 water rights for 60cfs have been issued in the lower Tucannon River, while additional claims for 133cfs have not been adjudicated. Flows in the lower Tucannon River, fall below the 65 cfs target more than 50 percent of the time between July and October which is limiting salmonid productivity. It is assumed that only verified rights should be considered for acquisition to meet target flows in the Tucannon River to ensure that instreams flows can be preserved. This may be challenging within this basin as water rights are based on consumptive use and have not been adjudicated.

Tenmile and Couse Creeks have very little water in the summer and fall. It is unknown how much water is legally or illegally withdrawn, from these streams. There should be no further appropriation of water from these streams due to existing critically low flows. Both of these streams have sections that go dry during the summer and salmonids concentrate in isolated pools or wet areas to try to survive. Small amounts of water (e.g. 0.5 cfs) are very important to these streams. Steelheads are present but flows are very limiting to production. There is a lack of specific data on historic flows or any water use in this sub-basin.

Mill Creek - There may be diversions in or above the town of Anatone on Mill Creek, and upper Mill Creek goes dry in summer and fall. The degree to which low flow is related to diversions and how much in "natural" is unknown. We have little or no information on diversions from this stream.

Meadow Creek - Water use in this stream is largely unknown. This basin has little salmonid value as indicated by Glen Mendel, (WDFW Fish program, personal comm.). Summer steelhead are present, but very limited.

Wawawai Creek – Water diversions are suspected, but there is no current documentation. Any additional water would be very important for this stream. The culvert at the bottom is being examined for repair to improve passage. Juvenile summer steelhead has been observed in this stream and adults have been observed attempting to enter the culvert, which appears to be a

barrier in all but the highest flows.

Alkali Flat Creek – diversions are unknown in this sub-basin. It is suspected that there are diversions near the town of Hay. Any increase in water would be valuable for fish. Flows are very limiting to summer steelhead production.

Penewawa Creek – This is a small stream with steelhead use that has very little water in the summer and fall. Any water we can protect or acquire would be valuable for fish production. Diversions are unknown.

Limited summer and fall flows significantly limit steelhead productivity in the above listed independent tributaries of the Snake River. Water is so limited that during some years adult steelhead either can't get into these streams at all or they are delayed, or there are stretches that they can't access because of little or no water. Low flows or lack of water affects adults in spring and juveniles in summer and fall in these sub-basins.

Yakima River Watersheds – WRIA's 37, 38, and 39

Low flows in the Lower Yakima River below Parker Dam and during the spring out-migration has been identified as one of the most limiting factors to salmonid production in the Yakima River Basin. Low flows are associated with high temperatures and predation which result in significant mortality, especially during years with below normal snow pack and associated spring flows. Juvenile steelhead and fall chinook tend to be affected to a greater degree than spring chinook due to their later migration timing.

Low flows during spawning and incubation periods for spring chinook can be significant during some years. If flows are too high during spawning there may be insufficient storage remaining in the reservoirs to support incubation flows during the fall months prior to fall and winter precipitation and an increase in instream flow. Acquisition of sufficient flows to ensure successful spawning and incubation would provide significant benefit, especially during drought years.

In addition to low main stem flows, there are several tributaries in which surface water is diverted to the extent that rearing, migration, and spawning habitat is significantly affected. In some instances, entire stream flows are diverted for agricultural purposes.

Within WRIA 39 of the upper Yakima Basin , Taneum Creek, Manastash Creek, Teanaway River, Big Creek, Little Creek, Swauk Creek, and Tributaries of the Wilson/Cherry Creek complex and others, all suffer from low flows to the extent that the salmonid production potential of these streams is significantly depressed. While most of the diversions are gravity surface diversions with associated diversion structures, some of the diversions are pump stations. With few exceptions, most of these diversions are for agricultural purposes. While the Bureau of Reclamation has been involved in flow restoration efforts in the Teanaway River, to the extent that flows are less limiting, summer flows in Manastash, Big, and Swauk Creeks continue to be very low, or non-existent.

Within WRIA 37 of the lower Yakima River Basin, low flows in the main stem during the spring and summer months are most limiting to salmonids, as discussed above. There are also some tributaries within this reach in which low flows are limiting. Ahtanum Creek, Blue Slough, Toppenish Creek, and Simcoe Creek suffer low flows due to irrigation diversions. It is difficult to assess the historic base flows of many of the smaller tributaries in the lower Yakima because they are supplemented by irrigation returns or used for controlled spill purposes. Ironically, some of the tributary flows are highest during the irrigation season and lowest during the late winter months. False attraction of adults is a problem in some of the tributaries which receive return flows from water diverted from the Yakima River.

While stream flows are not as limiting within WRIA 38, there are some exceptions. Cowiche Creek and Rattlesnake Creek suffer from low flows and fish passage barriers during the irrigation season. There is opportunity and local support to provide alternative water from the Tieton Irrigation District for water right holders in Cowiche Creek. Cowiche Creek and its tributaries have significant production potential for salmonids and extensive habitat which is currently inaccessible due to low flows. Flow is somewhat less limiting in lower Rattlesnake

Creek. However, the two gravity diversions can result in migration delays for spring chinook and bull trout in some years. Low flows for migration and spawning in the Lower Naches River appear to have largely been resolved by the recent purchase of the water rights associated with PP & L's Wapatox Power Plant by the Bureau of Reclamation and Department of Ecology. Low flow problems do exist in the Tieton and Bumping Rivers, but these flows are likely be better addressed through FERC licensing or negotiations regarding BOR project operations as storage dams exist on both of these streams.

Wenatchee River Watershed - WRIA 45

Low instream flows and dewatering occur naturally as a result of climatic and geological conditions within smaller tributaries of the Wenatchee River Basin. While further data collection and analysis is needed to further identify the extent at which water diversions affect instream flow in some sub-basins, the effect of surface diversions in some tributaries is evident. Low instream flows during late summer months are common in some tributaries and there appears to be significant annual flow variation. During years of low snowpack and drought, low flow periods limiting to salmonids can begin earlier and extend later in the season, due to surface water withdrawals.

Low stream flows are limiting to rearing and adult passage in Chumstick, Mission, Sand, Brender, and Peshastin Creeks as well as the lower Icicle Creek. Flows are recognized as a significant limiting factor in Peshastin Creek. The Peshastin Irrigation District Diversion at RM 4.8 contributes significantly to low flows or dewatering, resulting in a migration barrier and loss of rearing habitat. Flow restoration is determined to be a priority to provide access for bull trout and spring chinook.

The Icicle/ Peshastin water diversion at RM 5.7 on Icicle Creek contributes significantly to low flows and elevated temperatures throughout the lower stream reach. Adult salmonid passage and rearing habitat are significantly impacted by this diversion.

Derby Canyon Creek is a small stream which is annually dewatered below RM 1. There are 0.4 cfs of surface water rights and claims for another 1.1cfs. It is suspected that these diversions contribute to dewatering of the lower reaches of the creek, resulting in passage barriers and lost rearing habitat. While small sub-basins like Derby Canyon Creek have little potential to contribute significantly to the total production potential of the basin, little water is required to restore them, and they may provide critical refugia for rearing salmonids in some flow conditions.

Improving summer and early fall instream flows to increase available rearing habitat is recognized as a priority for restoration in the main stem Wenatchee River. For the purposes of the Water Acquisition Program, water acquisition in the mainstem Wenatchee is not a priority as it is unlikely that sufficient water or funding is available to measurably increase available rearing habitat.

Methow River Watershed -WRIA 48

Low instream flows and de-watering occur naturally in some reaches as a result of climatic and geological conditions within the Methow River Basin. De-watering of the main stem is known to be a natural occurrence in the vicinity of Robinson Creek during late summer and early fall annually. The extent to which water diversions affect main stem flows is not well documented.

Early Winters Creek has two diversions diverting up to 15 cfs of surface flow, which can have a significant impact on rearing habitat, adult steelhead and chinook passage, and contributes to low flows in the lower 1.3 miles of the creek.

There are four diversions within the annually dewatered reach of the upper Methow River (above RM 61), including a significant diversion of 1.8 cfs on Goat Creek. It is likely that this diversion contributes to earlier dewatering of the main stem during late summer months than would otherwise occur.

There are three identified water diversions on Wolf Creek. The lower 0.5 miles of the stream dewaters during most years after late July. Low flow hinders migration of spring chinook and bull trout and results in loss of rearing habitat and stranding of salmon and steelhead juveniles.

There are a total of five surface water diversions in the Chewuch River sub-basin, two of which are located on Eight Mile Creek. While water diversions may not be the most limiting factor to salmonid production in this basin, they contribute to lost rearing habitat and production potential in the Chewuch and Methow Rivers.

Rearing habitat is potentially limiting in the middle-main stem of the Methow River from surface diversions. Diversions are proportionally the highest during September during most years. Acquisitions in the main stem are not considered to be of highest priority due to the volume of water necessary to effect measurable change in rearing habitat. Tributary acquisitions may provide incremental increases in instream flow in the mainstem.

There are numerous surface diversions in Beaver Creek and water use exceeds flow during late summer and early fall in most years. Due to the number of diversions present, there may be significant opportunity to acquire water for instream flows in this sub-basin.

The are also diversions which contribute to low flows on Gold, Libby, and Black Canyon Creeks which contribute to loss of rearing habitat and create fish passage barriers. Diversions in Libby Creek may exceed summer base flows and eliminate potential rearing habitat.

The Twisp River is listed on the 303(d) list for temperature and instream flow deficiencies. The Methow Valley Irrigation District (MVID) diverts 24.6cfs from the Twisp River, about 46 percent of the mean flow in September. There are a total of seven surface diversions from RM 3.9 to the mouth. Low instream flows limit both fish passage and rearing habitat for salmonids. Acquisition should be focused on restoring flows up to approximately RM 4.

Okanogan River Watershed - WRIA 49

Stream flow in the Okanogan River, as well as most of the tributaries, have been altered primarily for flood control and irrigation. As a result, their natural hydrographs have been severely altered and are generally rated as "poor". Most of the tributaries of the Okanogan River are significantly diverted for irrigation purposes, resulting in adult migration barriers and lack of rearing habitat.

Due to varying geological and climatic conditions, many of the tributaries naturally suffer low flows during late summer and early fall and the tributaries are of relatively small size compared to other basins in eastern Washington. However, these small tributaries of the Okanogan provide critical rearing habitat for juvenile salmonids, especially those in which a significant proportion of flow originates from springs or groundwater. Some of the tributaries are capable of providing spawning habitat for summer steelhead but are generally too small to provide suitable spawning habitat for chinook. Due to significant alteration of off-channel habitat and hydrology in the mainstem of the Okanogan River, these small tributaries cumulatively provide critical rearing habitat, which is recognized as limiting in this basin.

Waters in Loup Loup Creek are heavily diverted and used for irrigation. Surface water withdrawals permitted account for only 0.1 cfs of the diversions in this creek, but claims amount to 2,366.9 cfs. The system is over allocated, and is usually dry in its lower reaches throughout the summer, precluding its use by salmonids. Due to the potentially uncertain nature of the status of these claims, any water acquisition in this basin should be carefully evaluated to ensure that acquired water could be preserved instream.

Surface water rights on Omak Creek, amount to a potential withdrawal of only 1 cfs. However, there are18 surface water claims, totaling 1.8 cfs. This creek has significant potential for recovery of both steelhead and spring chinook and is of somewhat larger size than many other tributaries of the Okanogan. However, habitat condition is ranked poor throughout the lower reaches of this creek, and concurrent habitat restoration would be needed with any flow restoration activities.

This variability of surface runoff in the Salmon Creek Basin is so great that surface runoff from the upper watershed is often insufficient to fill Conconully Reservoir or Salmon Lake. A substantial portion of Salmon Creek flows are diverted and stored within these reservoirs. There are 89 permits for surface water withdrawals on Salmon Creek, which total 2.9 cfs. In addition, there are another 137 surface water claims for a total of 408cfs. This system is significantly over-allocated and flows are a significant limiting factor to salmonid production. Prospective water rights must be carefully evaluated to ensure that acquired water remains instream.

Base flows in the summer and fall in Tunk Creek appear to fluctuate around 1 to 1.5 cfs throughout the lower reaches, and the lower ¾ mile of the stream may become dewatered during dry years. Recent monitoring by the Okanogan Conservation District in the upper Tunk Creek watershed, measured flows ranging from 0.83 to 17.7 cfs, with peaks occurring in May or June (T. Nelsen-- OCD). This creek has potential to provide critical rearing habitat for salmonids, and perhaps limited spawning habitat for summer steelhead within this reach of the Okanogan River.

There is a barrier falls located at approximately RM 0.75.

Aeneas Creek is primarily spring fed, thus there is little seasonal variation in the hydrograph relative to other Okanogan tributaries influenced primarily by snowmelt runoff. Currently, there are six permitted groundwater withdrawals on Aeneas Creek, with a potential yield of 3.8 cfs. There are two surface water withdrawals permitted with a potential yield of 0.2 cfs. There are five surface water claims with potential withdrawals of 3.6 cfs. Due to the spring fed nature of this stream, temperatures are likely to be moderated and provide suitable temperatures for rearing juvenile salmonids. In addition, the habitat in this stream is relatively intact. There is a barrier falls located at about RM 0.75.

Surface water withdrawals are made from Bonaparte Creek, its tributaries, and Bonaparte Lake. The MWG (1995) documented 124 permitted surface water withdrawals from Bonaparte Creek and another 106 surface water claims. Permitted withdrawals total 26.1cfs, while claims total 26.5cfs. The Bonaparte Water Users Association has water rights to 1080 acre-feet of water from Bonaparte Lake (Unpublished memorandum, USFS 1998a). Habitat conditions are generally ranked as poor throughout this creek and anadromous access is limited to the lower one mile of creek below the barrier falls. Summer steelhead spawning does occur in this stream.

There are nine permitted surface water rights on Siwash Creek, totaling 0.1 cfs. There are an additional 27 surface water claims totaling 6.5 cfs. Siwash Creek can be dry during late summer and early fall. Irrigation withdrawals peak at this time and may be the reason for such reduced surface flows. Another hypothesis is that Siwash Creek recharges groundwater draining to Antoine Creek, and Siwash Creek will only have surface flows during times when the groundwater "aquifer" is sufficiently recharged to spill water into the Siwash aquifer. Thus, further investigation in the hyphorheic connectivity of these sub-basins is prudent prior to acquiring water. Anadromous access is limiting to the lower 1.4 miles below a steep cascade.

According to MWG et al. (1995), there are 20 permitted surface withdrawals on Antoine Creek, yielding a potential removal of 7 cfs. There are additional 91 surface water claims for nine cfs. Groundwater withdrawals of 3.3 cfs are currently permitted, and an additional 76 claims are registered for 1.87cfs.

Fancher Dam reservoir entrains water from both Antoine and Mill Creeks and their tributaries. The water in Fancher Dam reservoir is used for crop irrigation on Fancher Flats during the months of May to October, annually. During this time, flow at the mouth of Antoine Creek is minimal and sometimes non-existent (D. Van Woert, personal communication). "Surface stream flow in the lower reach of Antoine Creek is often reduced to no flow during the driest part of the year. Antoine Creek has sometimes been completely dewatered in dry years due primarily to irrigation withdrawals" (USFS 1999). Anadromous fish access is limited to the lower 11.5 miles of the creek below the dam and falls.

Irrigation withdrawals are limited to the lower part of Tonasket Creek. According to MWG et al. (1995), there are 13 permitted surface withdrawals on Tonasket Creek, totaling 0.2 cfs. There are additional 70 surface water claims totaling 2.7 cfs. Other water withdrawals from Tonasket Creek and its tributaries in the Nine Mile Ranch subdivision area are suspected, as well as Mud

Lake Valley and Dry Creek areas. These withdrawals may be for irrigation, stock watering or perhaps domestic use. Anadromous access is limited to the lower 1.9 miles of stream due to a passage barrier at an impassable cascade extending to RM 2.4. Summer steelhead adults have been found in this reach.

Water supply to the Nine-Mile Creek drainage is limited by the arid conditions of this sub-watershed. Effect of groundwater withdrawals on stream flows has not been established, but they may be substantial.

According to MWG et al. (1995) there are 17 surface water claims totaling 6.3 cfs. There is currently only 1 surface water permit. Flows can be limited to non-existent, generally about 1 cfs, except during a brief period of snowmelt occurring generally during the spring. Snowmelt plays a most significant role in recharging ground waters to supply summer base flows. Due to its small size, this stream has very limited potential for spawning salmonids, but could provide important rearing habitat.

Although mainstem temperatures and flow are identified as being limiting in the Okanogan River, it is not expected that sufficient water is available for acquisition to address them with current funding programs. Therefore, acquisitions should be focused on tributaries providing critical rearing habitat and spawning habitat for anadromous salmonids.

Unfortunately, many of the diversions in the tributaries of this watershed are claims and not perfected rights, which may limit acquisition opportunities to restore instream flows. There may be substantial risk in acquiring water without appropriate investigation.